The Role of Citizen Science in Longwood Teaching & Learning, Research and Environmental Education

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Abstract

Citizen science recognizes the power of participation by the general public in scientific research. Citizen science programs have the potential to collect large amounts of data over vast geographic areas on well formulated scientific questions. Citizen involvement in science research ranges from participation in bird counts (e.g. Christmas Bird Count) to helping scientists identify galaxies (e.g. Galaxy Zoo), and most projects have online databases allowing ready access to these citizen-collected datasets. We have identified the potential of using citizen science programs and citizen-collected data in Longwood teaching and learning, research and environmental education. We report on using citizen science based case studies to teach scientific methodology in a general education class (GNED 261 – Exploring Science in Our World) where students examined data from a citizen science database to test hypotheses. We anticipate introducing citizen science based case studies in upper level teaching in the near future. Beyond classroom teaching, the potential of incorporating citizen science data into undergraduate research is immense. We report on ongoing student research of the impacts of urbanization on Virginia birds using two citizen science databases. Much potential exists for utilizing citizen science programs in teaching and research outside the science disciplines as well. Exposing Longwood students to the vast array of data collected by everyday citizens serves to further their own civic development as these citizen science programs highlight the importance of civic engagement, community, and environmental awareness. We also recognize the value of utilizing citizen science in fulfilling Longwood environmental education goals with newly established Center for Excellence in Environmental Education (CE[3]) connecting Longwood students, faculty and staff with local, regional and international community.

Expected Learning Outcomes

1) Promote active learning in STEM fields through case studies based on citizen science.
2) Explore how to use citizen science data in STEM teaching & learning and undergraduate scientific research.
3) Promote Longwood environmental education outreach activities through citizen science.

Levels of Citizen Science (Haklay, 2013)

Level 4 'Extreme'	• Collaborative Science – problem definition, data collection and analysis
Level 3 'Participatory science'	• Participation in problem definition and data collection
Level 2 'Distributed Intelligence'	• Citizens as basic interpreters
Level 1 'Crowdsourcing'	• Citizens as sensors

Citizen Science!

Participation of volunteer citizens in scientific studies as research assistants in collecting data, monitoring wild animals, plants and environmental markers (Cohn 2008).

E.g. Cornell Lab of Ornithology Programs

- Project FeederWatch - Count feeder birds for science
- Celebrate Urban Birds - Promotes conservation in cities
- Great Back Yard Bird Count - Snapshot of winter bird populations
- Project NestWatch - Monitor nests & collect breeding data
- YardMap - A social, interactive, mapping project about habitat
- eBird - A real-time, year-round bird checklist project

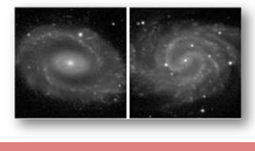
Environmental Education

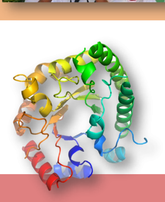
- Engages people to go out-doors and explore nature
- Increases awareness of natural and human-built world
- Changes skills, attitudes & behaviors over time (e.g. stewardship)
- Engages people in participation and action (e.g. What can we do to decrease bird window collisions?)
- Encourages people to make interdisciplinary connections at historical, artistic, political, and economic levels ("Tbilisi Declaration" 1977).
- Longwood Environmental Education
  - Goal to reach Longwood, local schools, the Farmville community and beyond
  - Center for Excellence in Environmental Education (CE[3])
  - Lancer Park Center for Environmental Education
  - Hull Springs Farm

For more information on Citizen Sciences go to http://www.birds.cornell.edu/citscitoolkit

Teaching & Learning

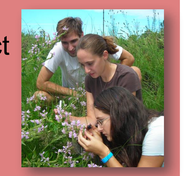
- Provides a data-rich learning environment that is scientifically grounded and widely accessible
- Provides demonstrative exposure to scientific method
- Provides experience with scientific research
- Stimulates interest to numerous relevant topics
- Provides opportunities to participate in data collection
- Longwood courses
  - GNED 261: Exploring Science in Our World
  - BIOL 435: Conservation Biology



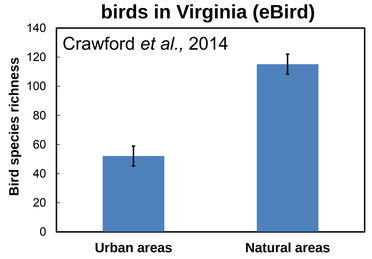


Research

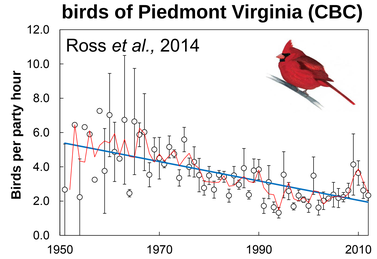
- Provides engaging topics
- A rich source of scientifically validated data
- Offers unrealized niches of unexplored research questions
- Provides spatially and temporally rich data
- Provides flexibility in scientific approach (e.g. collect or analyze or interpret data and draw conclusions)
- Most data readily available at no cost
- Longwood undergraduate research
  - Impacts of urbanization on Virginia birds using **eBird**
  - Population status of common wintering birds of Piedmont Virginia using the **Christmas Bird Count**



Impacts of urbanization on birds in Virginia (eBird)



Population status of common birds of Piedmont Virginia (CBC)



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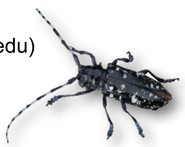

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A Summary of Citizen Science Projects

	Project name	Category	Scope	Web link
1	Audubon Christmas Bird Count	Birds	Monitoring winter bird populations	http://birds.audubon.org/christmas-bird-count
2	Celebrate Urban Birds	Birds	Promotion of urban bird conservation	http://celebrateurbanbirds.org/
3	eBird	Birds	A real-time, online checklist program	http://ebird.org/content/ebird/
4	The Great backyard Bird Count	Birds	Monitoring winter bird populations	http://gbbc.birdcount.org/
5	Bumble Bee Conservation	Invertebrates	Monitoring native bumble bees	http://www.xerces.org/bumblebees/
6	Monarch Larva Monitoring Project	Invertebrates	Long-term data on larval monarch populations	http://www.mlmp.org/
7	National Phenology Network	Phenology	Plant and animal phenology observation program	https://www.usanpn.org/node/35
8	Project BudBurst	Phenology	Plant phenology observation program	http://budburst.org/
9	Foldit	Biochemistry	A game on discovering new protein structures	http://fold.it/portal/
10	Natural Products Discovery Group	Biochemistry	Discovering soil based natural products	http://npdg.ou.edu/citizenscience
11	Asian Long-horned beetle project	Invasive species	Tracking the spread of this invasive beetle	http://asianlonghornedbeetle.com/
12	The Lost Ladybug Project	Invasive species	Monitoring native and invasive ladybugs	http://www.lostladybug.org/
13	Spring Monitoring Project	Water Quality	Monitoring water quality of desert springs	http://blackrocksprings.blogspot.com/
14	Maine Volunteer Lake Monitoring Program	Water Quality	Monitoring water quality of Maine lakes	http://www.mainevolunteerlakemonitors.org/
15	Great World Wide Star Count	Air Quality	Measure their local light pollution	http://www.windows2universe.org/starcount/
16	Lichen Monitoring	Air Quality	Monitor lichens as an indicator for air pollution	http://www.gsmit.org/CSLichen.html
17	IceWatch	Climate change	Monitoring climate change using ice record	http://www.natureabounds.org/IceWatch_USA.html
18	Mountain Watch	Climate change	Monitoring climate change using alpine plants	http://www.outdoors.org/conservation/mountainwatch/index.cfm
19	Citizen Weather Observer Program	Weather	Collect local weather data	http://www.wxqa.com/
20	Galaxy Zoo	Astronomy	Exploring space telescope images to identify galaxies	http://www.galaxyzoo.org/

For more information on Citizen Science go to **http://www.birds.cornell.edu/citscitoolkit**

CITIZEN SCIENCE! A NOVEL APPROACH TO ASSESS THE IMPACTS OF URBANIZATION ON VIRGINIA BIRDS

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ABSTRACT

It has been shown that bird diversity has changed in response to urbanization. However, most previous studies have been narrowly focused and limited to localized study sites. We studied the statewide impact of urbanization on Virginia birds using a citizen science database, eBird supported by the Cornell Lab of Ornithology and National Audubon Society. We assessed the impacts of urbanization on Virginia birds by comparing, 1) species richness, and 2) feeding guild composition between urban areas (cities/towns) and natural areas (state parks). Natural areas (N = 34, average richness = 115.18) had a significantly higher ($t = 5.659$, $P < 0.001$) species richness compared to urban areas (N = 34, average richness = 52.12). However, we failed to detect any significant differences of feeding guild composition between natural and urban areas for 7 feeding guilds of birds (N = 10; d.f. = 1; $F = 0.959$; $p = 0.226$). Our work shows the feasibility of utilizing citizen science databases to assess the impacts of urbanization on wildlife populations covering large geographic areas. Future research involves expanding the analysis to the southeast United States to understand continental scale patterns.

INTRODUCTION

- **Urbanization** has a significant negative impact on wildlife communities (McKinney, 2002) including bird diversity (Chace & Walsh, 2006
- However, most previous studies have been narrowly focused and limited to a few study sites.
- We studied the statewide impact of urbanization on Virginia birds using a **citizen science** database.

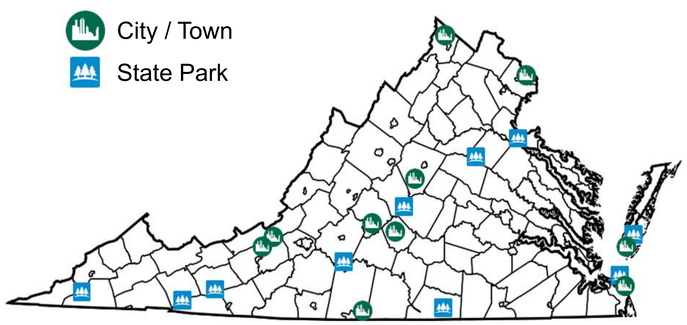
Citizen Science!

Participation of volunteer citizens in scientific studies as research assistants in collecting data, monitoring wild animals, plants and environmental markers (Cohn 2008).

Objectives

Assess the impacts of urbanization on Virginia birds by comparing,

1. Bird species richness
2. Bird species composition between urban areas (cities/towns) and natural areas (state parks)
3. Correlation between bird species richness and human population size



Distribution of sites utilized in this study to collect bird species richness and composition.

METHODS

Data Mining

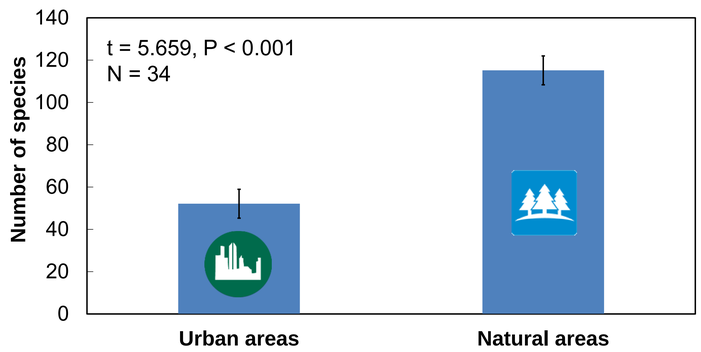
- We collected data on **bird species richness** in 34 urban areas and 34 natural areas using the eBird database (www.ebird.org).
- The Cornell Lab of Ornithology's The Birds of North America Online (http://bna.birds.cornell.edu/bna) was consulted to identify major food types of all bird species in Virginia.
- Bird species in a subset of 10 urban areas and 10 natural areas were classified in to 7 **feeding guilds** based on the major food type.

Data Analysis

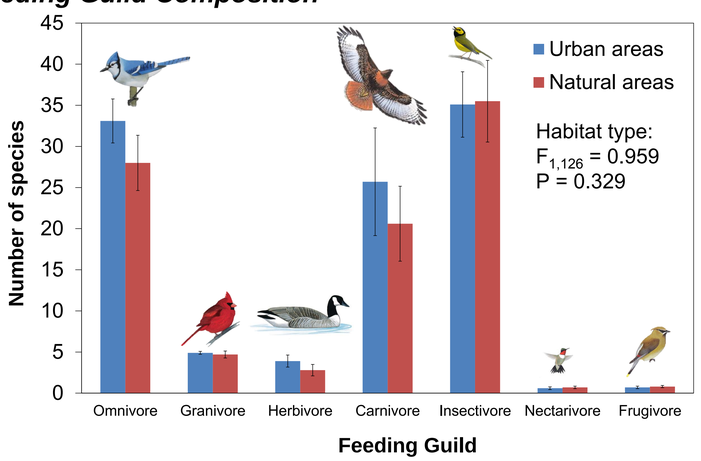
- Compared mean differences of species richness between urban and natural areas using Two-sample t-tests.
- Compared mean differences of feeding guild composition using two-way ANOVA considering species richness as the response variable, and both habitat (urban or natural) and feeding guild as predictor variables.

RESULTS

Bird Species Richness

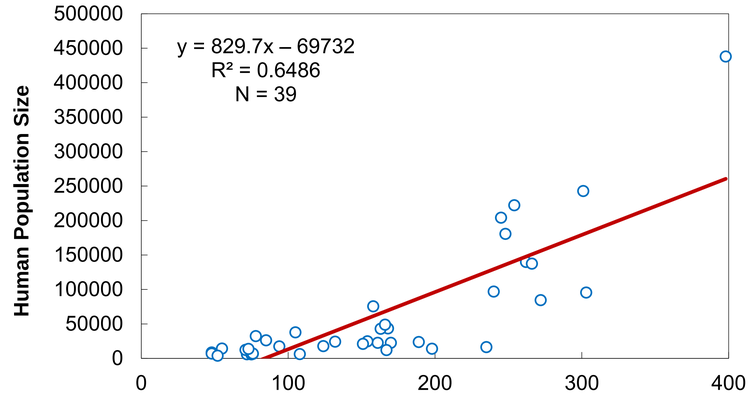


Feeding Guild Composition



RESULTS

Bird Species Richness Vs. Human Population Size



DISCUSSION

- A significant reduction in species richness of birds in urban areas compared to natural areas.
- However, failed to detect any significant differences of feeding guild composition between urban and natural areas.
- In contrary to the expectation, we found a positive correlation between bird species richness and human population size (Chamberlain et al. 2005).

Future Research

- Compare bird **species abundance** and **biomass** between urban areas and natural areas.
- Assess the impacts of **age of the development** on bird species richness, abundance, composition and biomass.
- Conduct field surveys and compare eBird data to field survey data to **ground-truth** the quality of eBird data.
- **Expand** this analysis to the southeastern United States.

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STATUS OF COMMON WINTERING BIRDS IN THE CENTRAL PIEDMONT OF VIRGINIA

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ABSTRACT

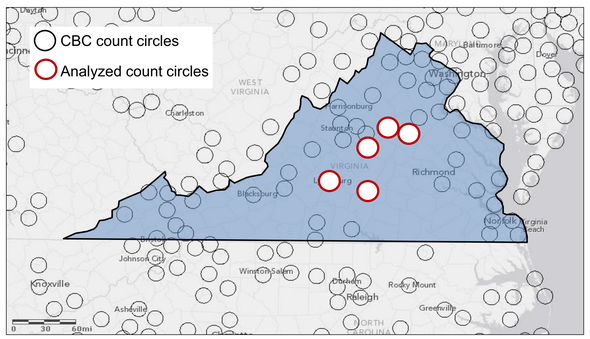
Several studies have shown a steady decline of common breeding birds in the eastern United States including Virginia. However, the long-term population dynamics of common wintering birds are poorly understood, especially for the Piedmont region of Virginia. We studied the long-term population dynamics of 12 common wintering birds in central Piedmont using Christmas Bird Count data from five count circles (Darlington Heights, Lynchburg, Warren, Gordonsville & Lake Anna). Linear regression models revealed significant population declines ($p < 0.01$) for Northern Cardinal (*Cardinalis cardinalis*), Carolina Chickadee (*Poecile carolinensis*) and Mourning Dove (*Zenaida macroura*), and significant population increases ($p < 0.0001$) for Eastern Bluebird (*Sialia sialis*), Turkey Vulture (*Cathartes aura*) and Red-tailed Hawk (*Buteo jamaicensis*). Additional analysis comparing average bird densities between Pre- and post-1980 resulted significant declines ($p < 0.05$) in Northern Cardinal (*C. cardinalis*), Carolina Chickadee (*P. carolinensis*), Tufted Titmouse (*Baeolophus bicolor*) and Mourning Dove (*Z. macroura*). Future research involves expanding the analysis to additional species and studying correlations between population trends and climate variables.

INTRODUCTION

- Previous studies have shown a decline in common wintering bird populations in the eastern United States (Butcher 2007).
- Long-term population dynamics are not well understood, especially in the Piedmont region of Virginia (Wolter 2008).
- We studied the long-term population dynamics of 12 common wintering birds in central Piedmont using Christmas Bird Count (CBC) data.

Objectives

- To analyze long-term population trends (1950-2012)
- To compare pre- and post-1980 bird abundances



CBC count circles modified from © http://netapp.audubon.org/cbcobservation/

METHODS

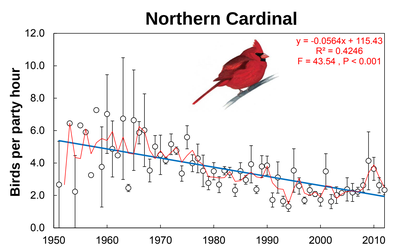
Data Mining

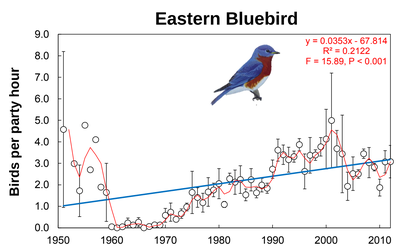
- Collected abundance data for **12 common wintering bird species** from **five count circles** in central Piedmont of Virginia (Darlington Heights, Lynchburg, Warren, Gordonsville and Lake Anna).
- Transformed abundance data in to birds per party hour.

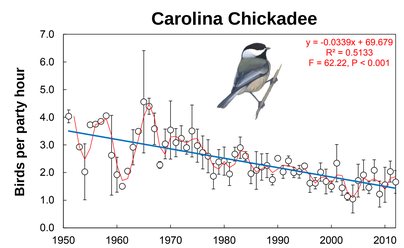
Data Analysis

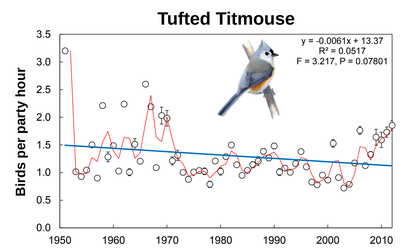
- Long-term population trends - Linear regression models
- Pre- and post-1980 bird abundances - Two-sample t-test

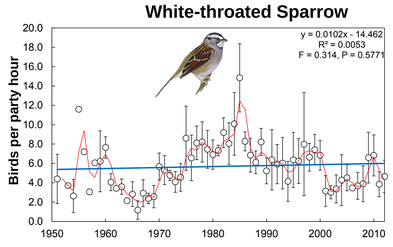
RESULTS

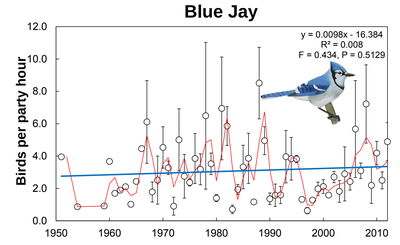


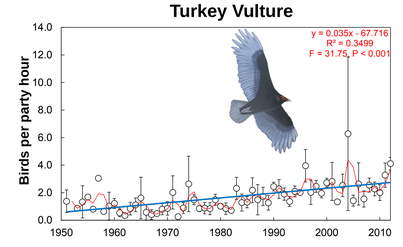


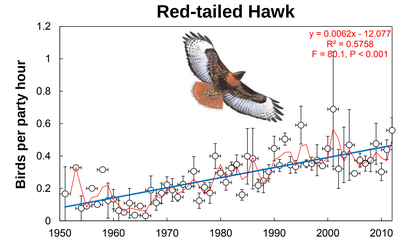


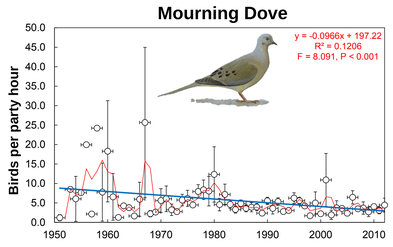


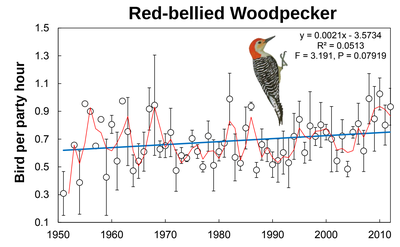


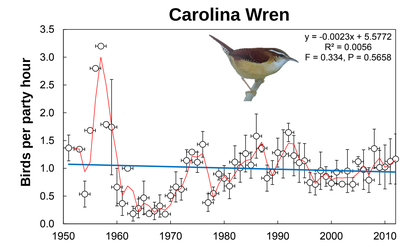


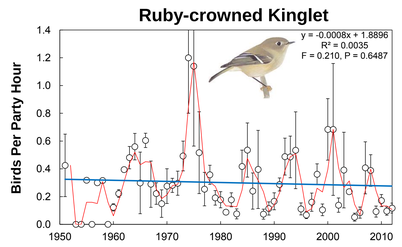












Major Findings

- Long-term population declines – Northern Cardinal, Carolina Chickadee & Mourning Dove
- Long-term population increases – Eastern Bluebird, Turkey Vulture & Red-tailed Hawk
- Pre- and post-1980 population declines - Northern Cardinal, Carolina Chickadee, Tufted Titmouse & Mourning Dove

Comparison of pre- & post-1980 bird abundances and population trends

Bird species	Population density (birds/party hour)		Population trend (%)	t-value	p-value
	Pre-1980 (±SE)	Post-1980 (±SE)			
Northern cardinal	4.73	2.70	-75.60	6.847	< 0.0001
Eastern bluebird	1.30	2.81	53.68	-5.150	1.0000
Carolina chickadee	3.05	1.94	-57.46	6.844	< 0.0001
Tufted titmouse	1.43	1.20	-18.43	1.849	0.0347
White-throated sparrow	5.03	6.25	19.51	-1.956	0.9724
Blue jay	3.01	3.13	3.78	-0.236	0.5929
Turkey vulture	1.10	2.18	49.52	-4.630	1.0000
Red-tailed hawk	0.16	0.38	56.33	-8.152	1.0000
Mourning dove	7.43	4.43	-67.70	2.459	0.0084
Red-bellied woodpecker	0.66	0.71	7.74	-1.276	0.8966
Carolina wren	0.96	1.04	7.11	-0.520	0.6975
Ruby-crowned kinglet	0.35	0.26	-33.02	-0.520	0.6975

DISCUSSION

- Significant **increase** in Eastern Bluebird (*Sialia sialis*) is most likely due to bluebird recovery programs by the North American Bluebird Society.
- Significant **declines** in Carolina Chickadee (*Poecile carolinensis*), Northern Cardinal (*Cardinalis cardinalis*) and Tufted Titmouse (*Baeolophus bicolor*) may be associated with changes in early successional habitats and land-use patterns.
- Knowledge of long-term bird population dynamics will aid in future efforts in bird conservation and management.

Future Research

- Expand the analyses to additional species to understand community-wide responses.
- Study the correlations between bird population trends and long-term changes in climate variables.

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